HOW TO FILL OUT THE BEEF FEEDLOT LIQUID WASTE UTILIZATION JOBSHEET

When viewing the Excel version of the jobsheet:
1 – the blocks highlighted in green are **required** for automated value calculation.
2 – the blocks highlighted in yellow are used for making manual calculations.
3 – the blocks highlighted in blue are the formula outputs, and require no user inputs.

Enter the landuser's name, county, date and who assisted with the planning.

Step 1. Resource Inventory

Inventory:

- acre-feet of liquid stored/retained *(Example 1 acre-foot)*
- nitrogen content of liquid. *(Example 2.00 lbs per 1,000 gallons)*
- ❖ **NOTE: Use judgement in selecting which table to use. If minimal amounts of solids will be transported to the retention structure, it is best to use Table 4-10a and use values of zero (0) for both phosphorus and potassium. If significant amounts of solids are likely to be transported and stored, use Table 4-10. Under any scenario, laboratory testing of the liquid component will provide the most accurate assessment. To convert (if using Table 4-10a) from lb N/acre-inch to lbs per 1,000 gallons (value needed in spreadsheet) divide the lb N/acre-inch by 27.**
- ammonia content of liquid (lb per 1,000 gallons from Chapter 4 values or runoff analysis if available) *(Example 2.0 lbs per 1,000 gallons)*
- phosphorus content of liquid (lb per 1,000 gallons from Chapter 4 values or runoff analysis if available) *(Example 17 lbs per 1,000 gallons)*
- potassium content of liquid (lb per 1,000 gallons from Chapter 4 values or runoff analysis if available) *(Example 20 lbs per 1,000 gallons)*

Step 2. Total Liquid Produced

Step 2a. Total gallons liquid produced

Calculate the total liquid produced. The calculation is:

Acre-feet x 325,851 gallons per acre-foot

For this example:

(1 acre-foot x 325,851 gallons per acre-foot = 325,851 gallons

Step 2b. Acre-inches liquid produced

Calculate the acre-inches of liquid produced. The calculation is:

Acre-feet x 12 acre-inches per acre-foot

For this example:

1 acre-foot x 12 acre-inches per acre-foot = 12 acre-inches

Step 3. Total Nutrients in Liquid Component

Step 3a. Total Nitrogen in Liquid Component

Calculate the lbs of nitrogen in the liquid component. The calculation is:

Total Gallons x lbs of nitrogen per 1,000 gallons

For this example:

Total Nitrogen in Liquid Component =325,851 gallons x 2.0 lbs nitrogen per 1,000 gallons = 652 lbs of nitrogen

Step 3b. Total Ammonia in Liquid Component

Calculate the lbs of ammonia in the liquid component. The calculation is:

Total Gallons x lbs of ammonia per 1,000 gallons

For this example:

Total Ammonia in Liquid Component = 325,851 gallons x 2.0 lbs ammonia per 1,000 gallons = 652 lbs of ammonia

Step 3c. Total Phosphorus in Liquid Component

Calculate the lbs of phosphorus in the liquid component. The calculation is:

Total Gallons x lbs of phosphorus per 1,000 gallons

For this example:

Total Phosphorus in Liquid Component = 325,851 gallons x 17 lbs phosphorus per 1,000 gallons = 5,539 lbs of phosphorus

Note: This value could be high if the producer regularly scrapes pens/holding areas. Use judgement in deciding on phosphorus values.

Step 3d. Total Potassium in Liquid Component

Calculate the lbs of potassium in the liquid component. The calculation is:

Total Gallons x lbs of potassium per 1,000 gallons

For this example:

Total Potassium in Liquid Component = 325,851 gallons x 20 lbs potassium per 1,000 gallons = 6,517 lbs of potassium

Step 3e. Total Nutrients in Liquid Component

Transfers products from steps 3a – 3d.

Step 4. Plant Available Nutrients (availability after mineralization)

Step 4a. Plant Available Nutrients after Mineralization. This step makes the following assumptions:

- Half of the Total Nitrogen is nitrate-nitrogen which is 100% available
- Half of the Total Nitrogen is organic nitrogen, which is 45% available

For this example:

Total Available Nitrate = 652 x 50% = 326 lbs of nitrate-nitrogen
Total Available Organic = 652 x 50% x 45% = 147 lbs of organic nitrogen
Total Available Ammonia = 652 x 100% = 652 lbs of ammonia
Total Available Phosphorus = 5,539 x 0.90 = 4,986 lbs of phosphorus
Total Available Potassium = 6,517 x 0.95 = 6,191 lbs of potassium

Step 4b. Total Available Plant Nutrients

The available nitrate and ammonia fractions are added to the available organic fraction for the total available nitrogen. The total available phosphorus and potassium are transferred from step 4a.

For this example:

Total Available Nitrogen = 326 lbs of nitrate-nitrogen + 147 lbs of organic nitrogen + 652 lbs of ammonia = 1,124 pounds of total available nitrogen

Step 4c. Total Available Plant Nutrients per 1,000 gallons

The mineralization/availability values from step 4a are applied to the values from step 1 to determine the available plant nutrients per 1,000 gallons

> *For this example:*
>
> *Total Available Nitrogen = 3.5 lbs/1,000 gallons.*
> *This number is derived from:*
> *2 lb total nitrogen/1,000 gallons. 50% of this total nitrogen is nitrate, and 50% is organic nitrogen. 100% of the nitrate is available and 45% of the organic nitrogen is available. Therefore: 2 x 50 % = 1 lb each of nitrate and organic nitrogen*
> *The nitrate is 100% available, and the organic is 45% available. Therefore, (1lb) + (1lb)(.45) = 1.45. This amount is added to the 2 lbs of ammonia that is 100% available, leaving a total of 3.5 lbs of available nitrogen per 1,000 gallons.*

Phosphorous and potassium amounts in manure runoff analysis are often expressed as elemental P and K. To convert to the oxidized forms, multiply P by 2.29 and K by 1.21 to get P_2O_5 and K_2O respectively. In addition, the mineralization rates of 90% for phosphorus and 95% for potassium are applied

> *For this example:*
> *Available Phosphorus = 17 lbs/1,000 gallons x 90% x 2.29 = 35.0 lbs P2O5 per 1,000 gallons*
> *Available Potassium = 20 lbs/1,000 gallons x 95% x 1.21 = 23.0 lbs K2O per 1,000 gallons.*

Step 5. Nutrients Required by Crop

To accurately determine the nutrients required by a crop, there are two critical components to quantify: (1) – realistic crop yield goals, and (2) – current soil test levels.

Step 5a. Realistic Yield Goals

Enter the expected yield for the current crop. There are spaces available for up to 3 separate crops. The expected yield is the basis for determining the nutrient requirement for the current crop. An unrealistic estimate of expected yield can result in either too many nutrients being applied creating potential for environmental contamination and inefficient use of the resource, or too few nutrients being applied, causing crop stress and limiting potential yield.

The expected yield should be based on realistic soil, climate and management parameters including crop variety, and may be determined from producer records or county yield averages, soil productivity tables, or local research. Because climate can have a dramatic effect on yields, expected yield should be based on at least 5 years' data. Extreme climate years should not be included in the analysis, as they may bias the results. Discard the high and low values, average the 3 remaining values, and add 5%.

Expected yields may be calculated in a variety of ways. In our example, the corn yields obtained on the field over the past five crop years were: 157, 146, 140, 80, and 142 bushels per acre. To estimate expected yield we eliminate the extreme low and high yields and take the average of the three remaining yields. Adding 5% to the over-all average will compensate for prospective favorable weather conditions and potential varietal improvements. The estimated yield is than, (146 + 142 + 140)/3 = 143 bushels, plus 5% = 150 bushels per acre.

Step 5b. Current Soil Test Levels

The nutrient status of the soil is a key component of a nutrient management plan. This information is used to make recommendations for nutrient application. **As per NRCS Nutrient Management Policy, a soil test no more than 5 years old is required**. In this section, enter the soil test values (ppm) for N, P (P_2O_5), K (K_2O), and other soil constituents as given in the report from the soil-testing laboratory.

For this example:
soil test values are:
10 ppm NO_3-N
9 ppm P_2O_5
30 ppm K_2O
pH 7.5
SOM 1.2%
no test taken for EC.
The soil tests were taken from the 0-3 foot soil depth in a coarse-textured soil.

Step 5c. Refer to Agronomy Technical Note #10 to determine the nutrients required by the crop.

Using the soil test results and considering the expected yield, record the estimated amounts of nutrients and other soil amendments needed to produce the expected yield. The land grant university or other approved soil test laboratories will base nutrient requirements for the crop on the soil test results, crop yields from field research, and local climatic conditions. Consult Agronomy Tech Note #10 (Wyoming Guide to Fertilizer Recommendations). Nutrient recommendations come from extensive research results from similar soils and climatic conditions to develop recommended nutrient rates.

For this example:
The 150-bushel corn crop requires:
205 lbs of nitrogen per acre
45 lbs of P_2O_5 per acre
185 lbs of K_2O per acre

Nutrient Sources - Credits

A number of nutrient sources for crop production are available before and after the crop is planted. One source is the inherent nutrients in the soil determined by soil test levels of nitrogen, phosphorus, and potassium. Others become available to the crop through a process of recycling through animals, plants, air, water, and organic matter. Nitrogen from legumes and organic waste mineralization are examples, as is nitrogen from irrigation water.

Nitrogen Credits

Step 6. Crop Nitrogen Requirement after Nitrogen Credit from Irrigation Water. Irrigation water, especially from shallow aquifers, can contain some nitrogen in the form of nitrate nitrogen. This nitrogen is available for crop use. To calculate the amount of nitrogen applied with irrigation water, determine the concentration of nitrate nitrogen in the water (in ppm or mg/L). This will require a water analysis. The amount of nitrogen added in irrigation water will equal the nitrate nitrogen concentration (in ppm or mg/L), multiplied by the **net** irrigation water applied (in acre-feet), times 2.7. The factor 2.7 converts ppm or mg/L and acre-feet into pounds per acre.

For this example:
18 net acre-inches of irrigation water are applied having a nitrate nitrogen concentration of 4.5 ppm.
N (lb/acre) = Concentration of NO_3-N (ppm or mg/L) X volume of irrigation (acre-feet) X 2.7 →18/12 X 4.5 X 2.7 = 18 pounds N per acre.

Therefore, the adjusted crop nitrogen requirement is 187 lb/ac (205 – 18 = 187).

Step 7. Crop Nitrogen Requirement after Nitrogen Credit from Previous Legume Crop. Rhizobium bacteria, via symbiotic relationships with legume plants, fix atmospheric nitrogen. Amounts of nitrogen added by legume production vary by plant species and growing conditions. Refer to local university extension information for the most appropriate legume nitrogen credits.

If no local information is available, use 40 pounds per acre for elevations below 6,000 feet and 30 pounds per acre for elevations above 6,000 feet**. Only apply this credit, if a legume has been part of the crop rotation since the last soil test**.

For this example:
Assume 30 pounds of nitrogen credit from a previous legume crop.

Therefore, the adjusted crop nitrogen requirement is 157 lb/ac (187 – 30 = 157).

Step 8. Nitrogen-based Liquid Application Rate

Once we have figured the values for both the supply and the demand side of the equation, we can calculate liquid application rates. Plants utilize N, P, and K in an approximate ratio of 5:1:5, and feedlot runoff supplies N, P, and K in an approximate ratio of 1:10:7. Therefore, it is necessary to calculate liquid application rates for each of the primary nutrients.

For this example for nitrogen:
The 150-bu/ac corn crop requires 205 lb/ac of nitrogen. Once we subtract the nitrogen supplied by irrigation water and that supplied via symbiotic fixation, we know we need to supply 157 lb/ac of nitrogen via liquid manure (205 - 18 - 30 = 157).

We also know that the feedlot runoff can supply 3.5 lb of nitrogen/1,000 gallons of liquid. Therefore, we can calculate a nitrogen-based liquid application rate.

> *For this example:*
> *The 150 bu/ac corn crop requires 157 lbs of N per acre be supplied by liquid manure.*
> *The liquid can supply 3.5 lb of N per 1,000 gallons.*
> *Therefore:*
> *157 lb/ac x 1,000 gallons/3.5 lbs of N = 45,400 gallons/acre, or 1.7 acre-inches per acre.*
>
> *NOTE: If this application rate exceeds the Available Water Holding Capacity of the soil at the time of application, the soil AWHC becomes the limiting factor, and is used to determine the liquid application rate.*

Step 9. Phosphorous-based Liquid Application Rate

We know that the 150-bu/ac corn crop requires 45 lb/ac P_2O_5.

We also know that the liquid can supply 35.0 lbs of P_2O_5 per 1,000 gallons of liquid. Therefore, we can calculate a phosphorus-based liquid application rate.

> *For this example:*
> *The 150-bu/ac corn crop requires 45 lb/ac* P_2O_5 *be supplied by the liquid.*
> *The liquid can supply 35.0 lb of* P_2O_5 *per 1,000 gallons.*
> *Therefore:*
> *45 lb/ac x 1,000 gallons/35 lb = 1,300 gallons/acre, or 0.05 acre-inches per acre.*

Step 10. Potassium-based Manure Application Rate

We know that the 150-bu/ac corn crop requires 185 lb/ac K_2O.

We also know that the liquid can supply 23 lb of K_2O per 1,000 gallons. Therefore, we can calculate a potassium-based liquid application rate.

For this example:
The 150-bu/ac corn crop requires 185 lb/ac K_2O be supplied by the liquid.
The liquid can supply 23 lb of K_2O per 1,000 gallons.
Therefore:
185 lb/ac x 1,000 gallons/23 lb = 8,000 gallons/acre, or 0.3 acre-inches per acre.

Because of the significant differences between the nitrogen and phosphorous application rates, a phosphorous risk-assessment tool is needed to help determine the limiting nutrient. Refer to Agronomy Technical Note #15, or contact the State Conservation Agronomist for help in utilizing this risk assessment tool.

Step 11. Calculate Approximate Acres of Crop Needed

To calculate the approximate acres of crop needed, divide the acre-inches of liquid produced (from step 2b) by the application rate for each respective nutrient.

For this example:

Nitrogen-based
Acre-inches = 12 acre-inches
Application rate = 1.7 acre-inches/acre
Acres needed = 12 acre-inches x 1 acre/1.7 acre-inches = 7 acres

Phosphorous-based
Acre-inches = 12 acre-inches
Application rate = 0.05 acre-inches/acre
Acres needed = 12 acre-inches x 1 acre/0.05 acre-inches = 240 acres

Potassium-based
Acre-inches = 12 acre-inches
Application rate = 0.3 acre-inches/acre
Acres needed = 12 acre-inches x 1 acre/0.3 acre-inches = 40 acres

If calculating the approximate width of vegetation (grass filter strip, cropland, pasture or rangeland) simply multiply the acres required by 43,560 and divide by the length of the vegetation to receive runoff water. The assumption made here is laminar flow across the vegetated area.

Step 12. Recommended Timing of Application

Record the planned method and timing of liquid application in this block. The timing and method of nutrient application have a significant affect on the efficiency of nutrient use by plans. Avoid applying manure in the winter and on frozen or snow-covered ground.

Step 13. Operation and Maintenance

Waste Utilization Plans should be reviewed annually by the producer, and a more thorough review performed at least every 5 years. Any significant change to the operation warrants a review and/or modification to the plan.

Field records should be maintained for at least 5 years, though some producers may wish to retain records indefinitely.

Application equipment should be calibrated so that it will apply nutrients to within 10% of the expected rate. Uniform application across the field is vital. Generally, no more than a 10 – 15% variance in the required application rate from the actual amount applied is allowed.

Step 14. Additional Specifications and Notes

Write any additional specifications and notes in the box provided. Additional notes may include soil water holding capacity constraints not previously noted, special nutrient requirements of the crop, equipment constraints, constraints due to pest pressures, residue limitations, conservation buffer requirements, local regulations, and any other information of interest to the producer. Additional notes may also refer to sources of information used to calculate available nutrients and nutrient requirements.